

A FURTHER SYSTEMATIC STUDY OF THE
GENUS *ACARUS* L., 1758 (ACARIDAE, ACARINA),
WITH A KEY TO SPECIES



BY
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A FURTHER SYSTEMATIC STUDY OF THE GENUS *ACARUS* L., 1758 (ACARINA)

By D. A. GRIFFITHS

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I. INTRODUCTION

VIRTUALLY on the eve of the publication of my revision of the genus *Acarus* L., 1758 (Griffiths, 1964) I found a thriving population of the species here described as *Acarus nidicolous* sp.n. in the grounds of the Pest Infestation Laboratory. The chaetotaxy of the dorsum, in particular the length of setae *la* and *d*₁ to *d*₄, and the results of crossing it with the species of the *Acarus siro* complex was such that had this taxon been discovered earlier, some of the taxa which in the revision were placed as specimens *incertae sedis* would have been given specific status. More recently, Dr. van Eyndhoven, Dr. D. Furman and Dr. D. J. Johnston kindly presented me with *Acarus* material which they considered did not correspond to any of the forms included in the revision.

Thus, within a few months of completing a long study, it became necessary to prepare a second paper, as a consequence of which the number of species in the genus is almost doubled, an accurate reflection of the ever-changing situation in acarine taxonomy at this present time.

The descriptions which appear within follow the pattern used to re-describe *Acarus farris* Oudemans, 1905 in Griffiths, 1964. They were made with a new microscope

and, as a result, I have discovered some omissions and some mistakes in my previous descriptions of the *Acarus hypopi* which I will amend here.

Firstly, a pair of supra-coxal setae are present in the motile and inert hypopal forms. They are situated above coxae I, respectively. In the motile hypopi they are similar in size and shape to the supra-coxal setae of *Acarus nidicolous* (Text-fig. 16). Those of *Acarus immobilis* Griffiths, 1964 are much shorter.

Secondly, in the motile *Acarus* hypopi and, so far this appears to be true for motile hypopi of many other genera within the family, the structure which I termed seta *ba* on tarsus I (see Text-figs. 10 and 21 of Griffiths 1964) is actually solenidion ω_3 , seta *ba* is absent. This rule also applies to the inert hypopus of *A. immobilis*, the seta labelled *ba* in Text-fig. 28 of Griffiths 1964 is a minute solenidion ω_3 .

2. GENERIC CHARACTERS

The generic characters of the adult stage as given in Griffiths 1964 still stand. In addition, I am now satisfied that the morphology of the female reproductive system is sufficiently different from that of closely related genera for it to be used as a diagnostic character. It is described in Text-fig. 1.

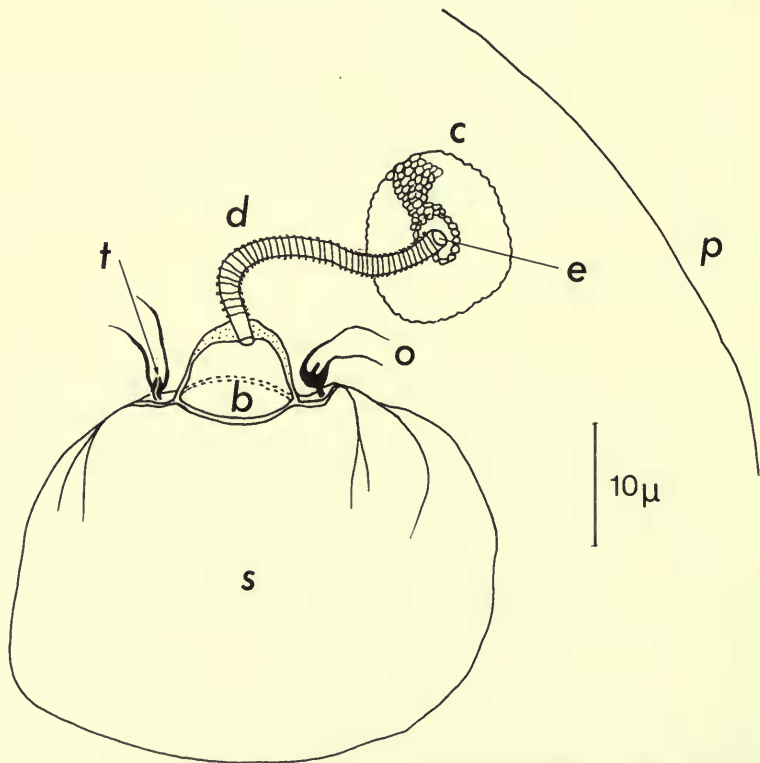


FIG. 1. *Acarus siro* L., ♀ reproductive system; p. posterior margin of body; c. chitinised, saucer-like depression in body wall; e. opening of expansible tube (d); b. chitinised, bell-shaped structure attached to which is a thin walled, dilatible sac (s) t. chitinised opening to thin walled oviduct (o).

Zatchvatkin 1941 (see p. 115 in the English Translation by Ratcliffe & Hughes 1959) stated that "the setae of the dorsal surface [in *Acarus hypopi*] are longer than in the hypopi of all other representatives of the family—*sc* [scapular setae] being particularly long. The fact that the hypopus of *A. nidicolous* sp.n., described herein, has short scapulars which barely reach the posterior margin of the propodosomal shield (Text-fig. 16) means that the relative length of the scapular setae can no longer be used as a diagnostic character at generic level. As more species are described, it is becoming increasingly difficult to find characters which can serve to separate motile hypopi of the family Acaridae into their respective genera. The practice of describing new species and especially new genera based solely on the hypopal form must be considered of doubtful benefit to acarine taxonomy.

3. MORPHOLOGICAL VARIATION

In my revision of the genus *Acarus* (Griffiths, 1964) material representing eight taxa was designated as specimens *incertae sedis* because, at the time, there was no way of determining whether the morphological differences exhibited by these taxa represented intra-specific or inter-specific variation. Material collected since 1964 and the results of nutritional experiments performed on sibling females of *A. siro* has now helped to clarify the position.

In Griffiths 1966 I showed that the tarsal length of adults varied according to the nutritional quality of the food they received during the pre-adult period. An example of this type of variation in a wild population is represented by Text-figures 23 and 24. Recently, I have examined the effect which high and low nutrient diets have upon the growth of the dorsal hysterosomal setae. Examples of the results obtained for groups of sibling females are illustrated in Text-figs. 2a and b. A poor diet (Fig. 2b) produces short, thin setae whereas a rich diet favours longer, thicker ones (Fig. 2a). Their length expressed as a percentage of the respective idiosomal length is given below.

Setal length as percentage of idiosomal length

Setae	♀ reared on poor food (Text-fig. 2b)	♀ reared on rich food (Text-fig. 2a)
d_1	4.6	8.6
d_2	7.7	15.6
d_3	9.4	14.4
d_4	9.2	15.9
la	6.2	10.8
lp	8.3	13.3
$sa e$	7.8	11.4

Seta d_2 shows the greatest variation. It is an interesting point that in the ecologically isolated species *Acarus gracilis* seta d_2 is much longer than d_1 or d_3 (Text-fig. 8) and serves to distinguish this species from all *Acarus* species.

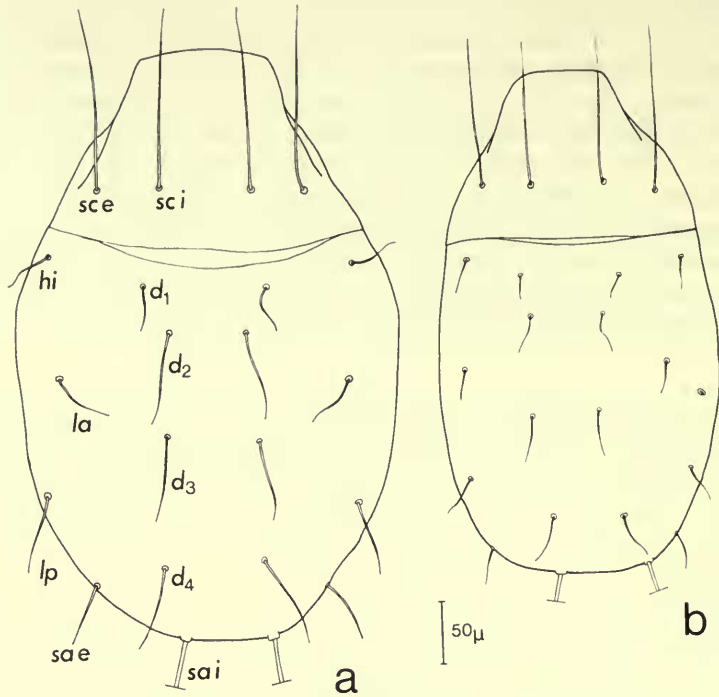


FIG. 2. *Acarus siro* L., idiosoma of sibling ♀♀ illustrating variation in length of dorsal setae (d_1 to d_4), brought about by exposing pre-adult stages to (a) a rich diet and (b) a poor one.

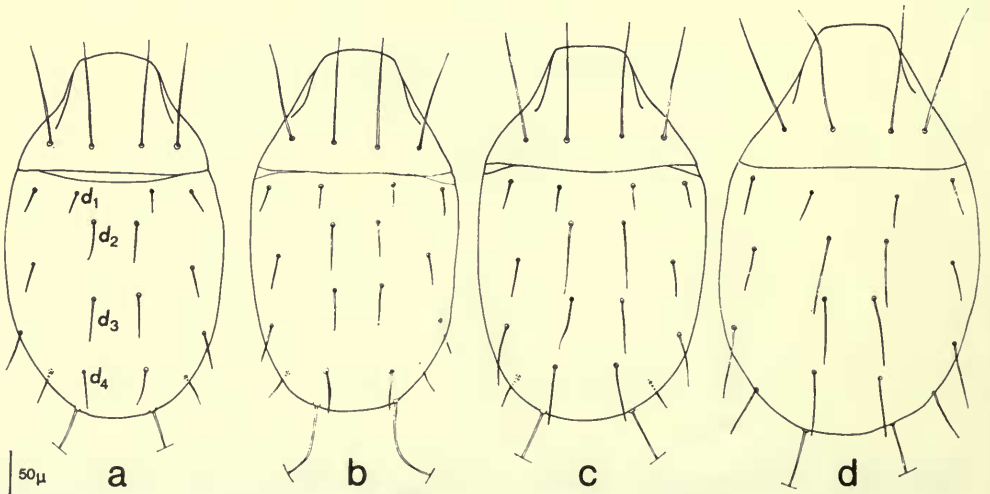


FIG. 3. *Acarus siro* L., idiosoma of ♀♀ taken from a natural population, showing extreme range of variation in length of dorsal setae.

I have found one population of *A. siro* in which the length of the hysterosomal setae is extremely variable. This was taken from a bag of oatmeal which had been left in a garden shed for more than five years. The range of variation in setal length exhibited by the females of this population is illustrated in Text-fig. 3. It should be noted that in individuals with the longest setae, the tips of the d_3 dorsals overlap the bases of the d_4 pair. However, in the vast majority of the many populations of *A. siro* which I have examined, the length of the dorsal setae d_1 to d_4 is never as great as the distance between its base and the base of the dorsal seta immediately posterior to it.

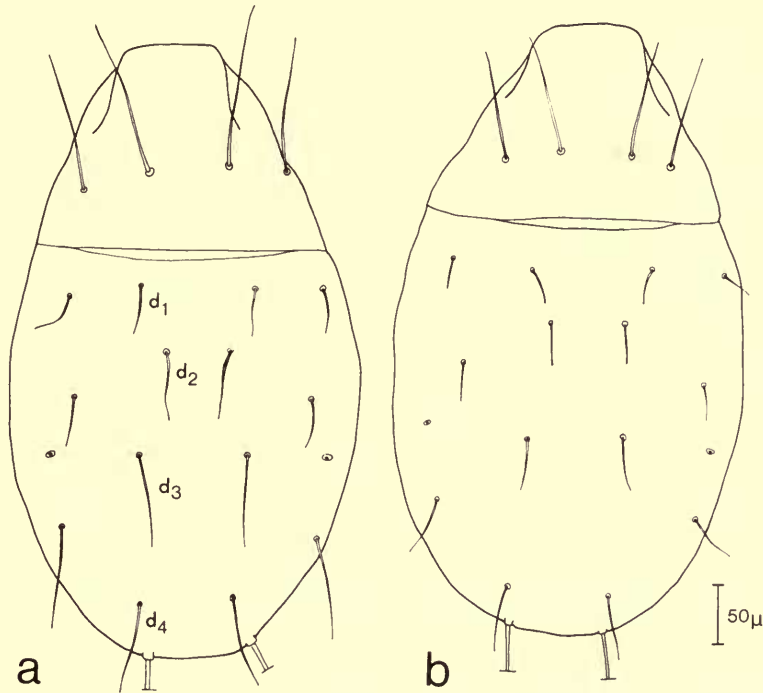


FIG. 4. *Acarus immobilis* Griffiths. Idiosoma of ♀♀'s taken from a seven year old stock laboratory culture, illustrating extremes of variation in length of dorsal setae (d_1 to d_4).

Some populations of *A. immobilis* and *A. farris* which I have obtained since 1964 also exhibit variation in dorsal setal length. But, so far, I have not found an individual of either species in which the length of seta d_2 or d_3 exceeds the distance between the base of d_2 and d_3 or d_3 and d_4 . Text-figure 4 gives examples of the extremities of the range of variation found in a population of *A. immobilis*, cultured in the laboratory for seven years.

After studying many populations representing the *A. siro* species complex, I believe the tendency in most populations is towards short dorsal setae. But, at the extreme range of variation so far observed (i.e. in *A. siro*), the tips of the d_2 setae, when projected backwards in a straight line, often overlap the bases of pair d_3 .

There is another group of species, described herein for the first time, in which the

dorsal setae are usually long so that the tips of d_1 , d_2 and d_3 distinctly overlap the base of the seta next in line (e.g. Text-fig. 9). But, in two species (*A. nidicolous*, which I have in culture and *A. macrocoryne*, known from two preserved populations) individuals can be found in which some dorsal seta are shorter than the distance separating the relevant bases (Text-fig. 5).

Previously, the shape of solenidion ω_1 on tarsus II was the only diagnostic character which, by itself, could be used to distinguish all the species in the genus. Plates I, II and III illustrate that this is now no longer possible.

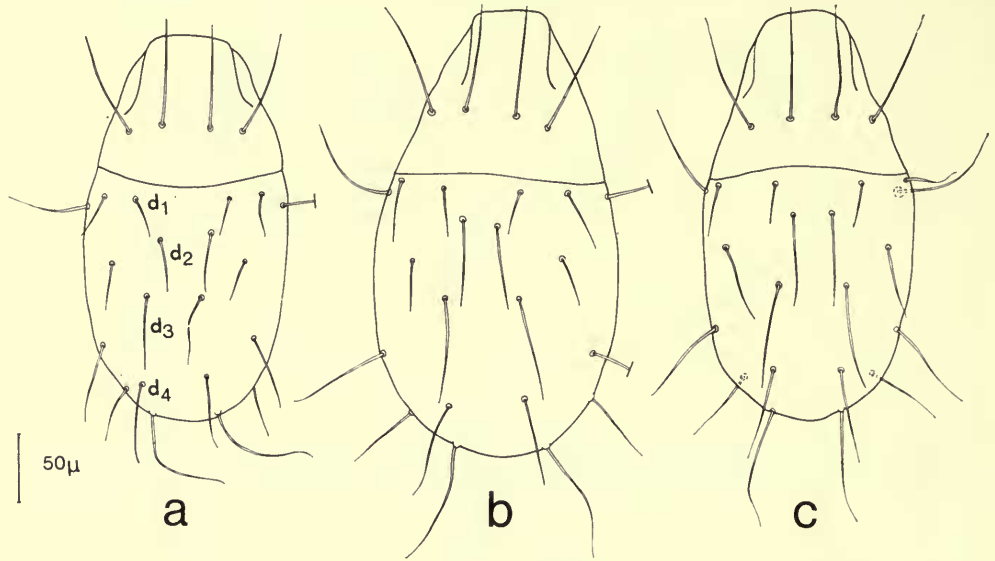
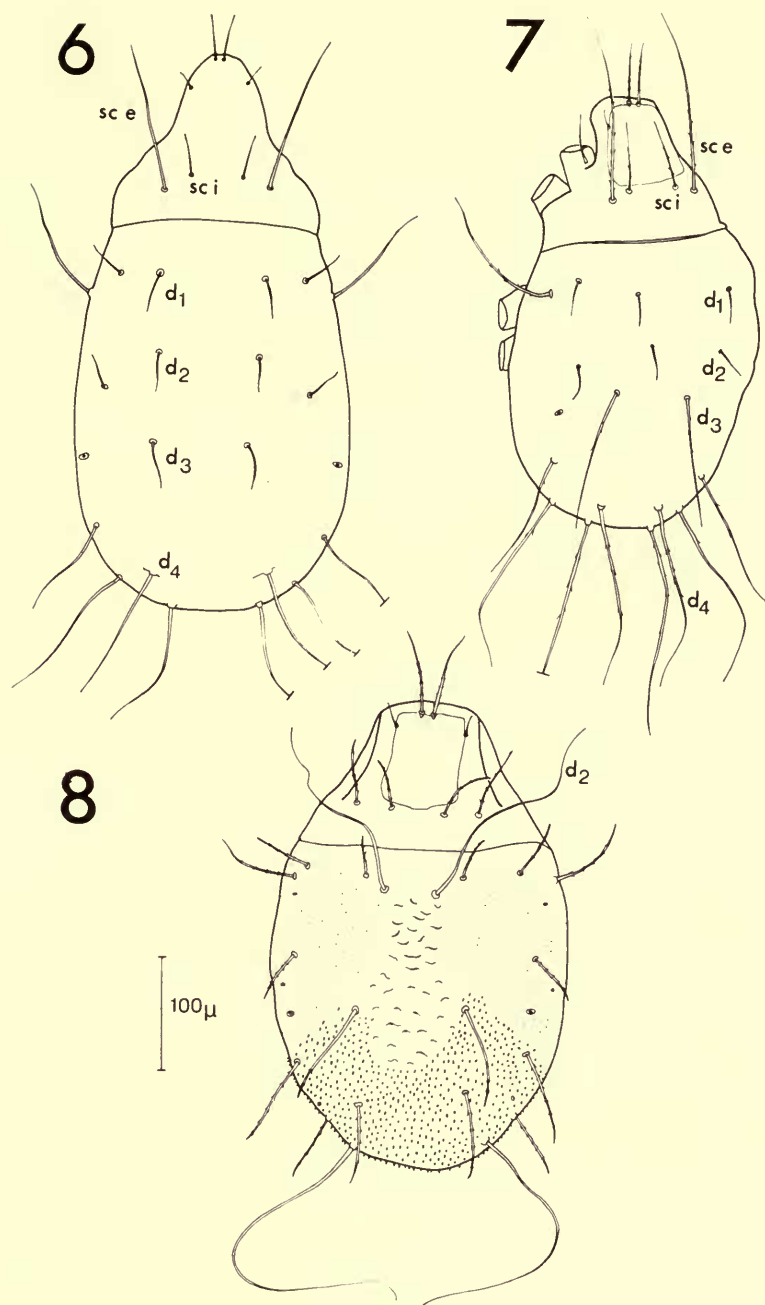


FIG. 5. *Acarus macrocoryne* sp.n. Idiosoma of ♀♀'s taken from a natural population showing range of variation in length of dorsal setae (d_1 to d_4).

Prior to this publication, genu I of *Acarus* males was said to bear two large and one small process and, ventrally, femur I extended into a strong conical spur (Text-fig. 11). The new species described here include one in which the genu bears a single large process sometimes subtended by a much smaller one and another species in which the genual processes are completely lost with the femoral spur considerably reduced in size. I have also seen a single *A. immobilis* specimen in which there is only one large genual process, similar to the condition occurring in *A. macrocoryne*.

It is hoped that the above discussion on morphological variation will provide an insight into why certain taxa (some previously described as specimens *incertae sedis*) have been given specific rank whilst others have not. It has been dealt with in some detail because despite the problem of discontinuous variation, I have had to use the characters which exhibit this phenomenon in order to provide a key to species. Therefore, identifications based on single specimen samples, or samples not properly prepared for microscopic examination, may not be reliable. It is perhaps heartening that the five known hypopal forms are easily distinguishable.



FIGS. 6, 7, 8. 6, *Acarus mirabilis* Volgin. ♀. Dorsum of idiosoma; external scapular setae *sc e*; internal scapular setae *sc i*; dorsal setae *d*₁ to *d*₄. Re-drawn after Volgin (1965). 7, *Acarus tyrophagoides* (Zachvatkin) ♀. Dorso-lateral view idiosoma. 8, *Acarus gracilis* Hughes ♀. Dorsum of idiosoma.

4. PREPARATION OF MATERIAL FOR MICROSCOPIC EXAMINATION

Before making a permanent mount, the specimens require to be cleared. Add two or three specimens to a drop of 70 per cent lactic acid and cover with a number 0, one cm diam. cover-slip. Place on a slide-warmer or in an oven at 50–60°C for one or two days.

Before making a permanent preparation, the lactic acid should be neutralised by placing the cleared specimens in a drop of Vitzthum's fluid* for up to one hour or more. This can best be achieved by surrounding the cover-slip of the temporary lactic acid mount with Vitzthum's fluid, using the fluid to float off the cover-slip. The specimens can then be pushed to a clean spot of fluid with the tip of a very fine needle. Finally, remove to a clean slide and mount in Berlese's fluid.

If more than one specimen is available, some should be mounted in a dorso-ventral position, others should be manoeuvred so that solenidion ω_1 on tarsus II can be viewed laterally. One specimen per slide under a small cover-slip is preferable. The key to adults is based on material prepared as above and examined by means of phase-contrast microscopy. An oil-immersion objective of high power is required in order to assess the degree of pectination of hysterosomal setae.

5. KEY TO ADULTS AND DESCRIPTION OF SPECIES

(i) KEY TO ADULTS

- | | | |
|---|---|---------------------------|
| 1 | External scapular setae (<i>sc e</i>) more than twice as long as internals (<i>sc i</i>), e.g. Text-fig. 6. | 2 |
| – | External scapulars about equal in length to internal pair, e.g. Text-fig. 10. | 3 |
| 2 | Seta d_3 long, equal or almost equal in length to d_4 and at least three times as long as d_1 or d_2 which are short (Text-fig. 7). Solenidion ω_1 with a stout shaft and distinct terminal head. | <i>A. tyrophagoides</i> . |
| – | Seta d_3 short, about equal in length to d_1 and d_2 , so that all three are much shorter than d_4 (Text-fig. 6). | <i>A. mirabilis</i> . |
| 3 | Dorsal setae d_2 four to five times longer than d_1 and twice length of d_3 (Text-fig. 8). Solenidion ω_1 usually slender, always tapering towards the apex (Pl. I, fig. 3). | <i>A. gracilis</i> . |
| – | Length of d_2 intermediate between length of d_1 and d_3 , never more than three times longer than d_1 and at most a little longer than d_3 . | 4 |
| 4 | Ventral distal spine <i>s</i> of tarsus I and II (not tarsus I of ♂) large, about equal in length to length of tarsal claw; ventro-posterior margin concave, claw tip directed backwards (Pl. IV, fig. 1). Solenidion ω_1 recumbent with distinct 'goose-neck' before terminal expansion (Pl. I, fig. 4). Usually, dorsal setae are short (see p. 89). | <i>A. siro s. str.</i> |
| – | Ventral distal spine <i>s</i> slender, about half length of tarsal claw; ventro-posterior margin of claw convex, claw tip directed forwards (Pl. IV, fig. 2). | 5 |
| 5 | Hysterosomal setae <i>hi</i> , <i>la</i> , <i>lp</i> and dorsals d_1 to d_4 short. In particular, the length of dorsal seta d_2 or d_3 does not exceed the distance between its base and base of the dorsal seta immediately posterior to it. (e.g. Text-figs. 2a and b). | 6 |
| – | Hysterosomal setae <i>hi</i> , <i>la</i> , <i>lp</i> and dorsals longer; generally, in the majority of individuals of a given population, the length of d_2 and d_3 is greater than distance between its base and base of the seta immediately posterior to it (e.g. Text-fig. 15). (See p. 90 for details of setal length variation). | 8 |
| 6 | Solenidion ω_1 with sides almost parallel, expanding into a distinct egg-shaped terminal head which at widest part is wider than widest portion of stem (Pl. I, figs. 1 & 2). | |

* Chloral hydrate 50g, Phenol 45g, Distilled water 5cc.

- Femoral spur and genual processes on leg I of ♂ normal (e.g. Text-fig. 11).
- Solenidion ω_1 without distinct egg-shaped terminal head: ♂ leg I normal or with reduced spur and genual processes absent *A. immobilis*. 7
- 7 Male leg I with normal spur and two tooth-like genual processes (Text-fig. 11)*. Solenidion ω_1 short, compact, with sides expanding gradually from the base then narrowing to an indistinct neck before expanding into a terminal head. Width of widest part of head equal to width of widest portion of stem (Pl. II, fig. 1). *A. farris*
- Male leg I with femoral spur much reduced so that seta *vF* arises almost at spur apex; genual processes absent. (Text-figs. 33 & 35). Solenidion ω_1 much more slender, with a distinct neck in distal half (Pl. II, fig. 2). *A. calcarabellus* sp.n., p. 107
- 8 Scapular setae with one or at most two pectinations, hysterosomal setae smooth†, long (especially those of opisthosoma) terminating in fine whip-like endings (Text-figs. 27 & 28). Solenidion ω_1 short with parallel sides (Pl. III, fig. 2). *A. chaetoxysilos* sp.n., p. 105
- Scapular setae strongly pectinate; hysterosomal setae with varying degrees of pectination but some opisthosomal setae *always* pectinate 9
- 9 Hysterosomal setae *d*₂, *d*₃, *sa i* and *sa e* strongly pectinate; also pectinations usually but not always present on *hi*, *d*₁, *la* and *lp*. 10
- Setae *d*₂ and *d*₃ smooth as are *hi*, *d*₁ and *la*; setae *lp* and *sa i* may also be smooth 11
- 10 Solenidion ω_1 large, expanding gradually from the base into a large swollen tip; the whole solenidion slightly curved (Pl. II, fig. 4). Male with normal femoral spur and a single large tooth-like process on genu I (Text-figs. 22–24). *A. macrocoryne* sp.n., p. 102
- Solenidion ω_1 short and thick, as thick as or thicker than basal portion of solenidion ψ of tibia; sides parallel with an indistinct terminal head (Pl. II, fig. 3). Male genual processes normal in British populations (Text-fig. 11); known from one specimen from U.S.A. in which genu I bears a single tooth (Text-fig. 12). *A. nidicolous* sp.n., p. 93
- 11 Hysterosomal setae of ♀ including sacrals are smooth (Text-fig. 39). ♂ sacrals sparsely pectinate but remainder of hysterosomal setae are smooth. Supra-coxal seta long, tenuous and sparsely pectinate (Text-fig. 39). Solenidion ω_1 short, strong, terminating in an egg-shaped head, with convexity of one side more distinct (Pl. III, fig. 3). Specimen *incertae sedis* ex cocoanuts, Brazil, p. 110
- Both sexes with opisthosomal setae *lp*, *d*₄ and sacrals pectinate. Supra-coxal seta long and strongly pectinate 12
- 12 Solenidion ω_1 with a slender shaft terminating in an obvious egg-shaped head. (Text-fig. 38 and Pl. III, fig. 4). Specimen *incertae sedis* ex citrus fruit, Formosa, p. 109
- Solenidion ω_1 short, with a thick shaft terminating in an egg-shaped head (Pl. III, fig. 1). Specimen *incertae sedis* ex water-chestnuts, China, p. 112

(ii) *Acarus nidicolous* sp.n

The gross morphology resembles that of the adults of the *Acarus siro* complex (Griffiths, 1964) and, in the main, only the differences are discussed below.

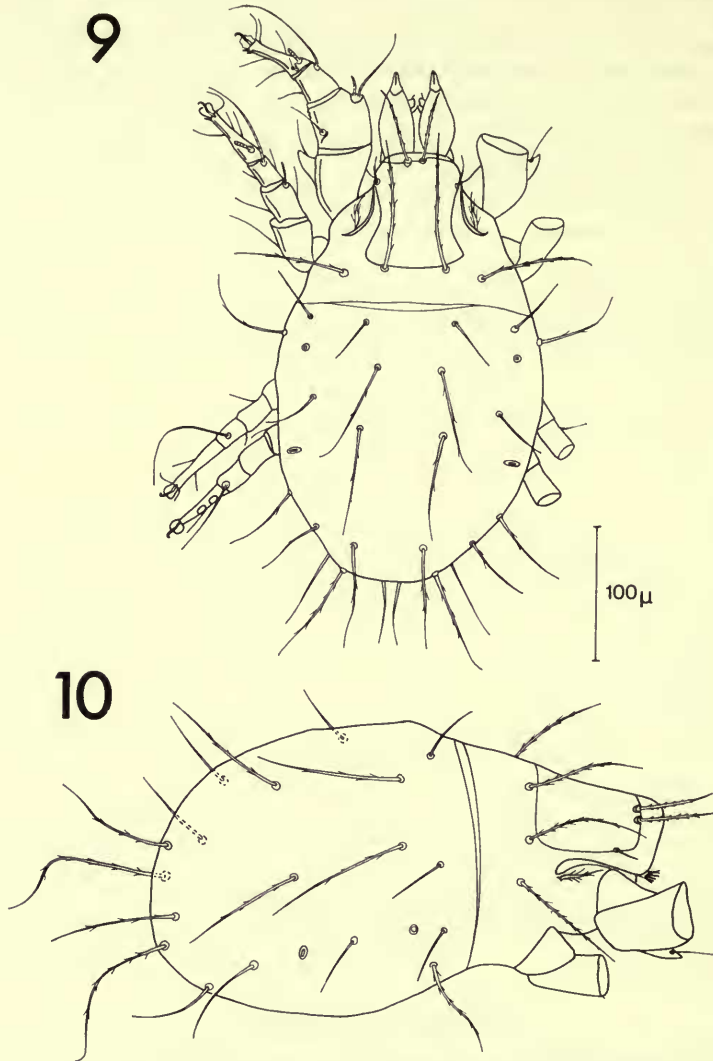
MALE. Length of idiosoma of five males, reared on a wheat germ and yeast mixture at 90 per cent relative humidity and 20°C, = 0.365 mm average. Idiosomal

* The two species in couplet 7 are easily separated on secondary sexual characters on leg I of the ♂. In the absence of ♂♂'s, identification is based on shape of solenidion ω_1 on tarsus II, viewed laterally and is more difficult. *A. calcarabellus* is very rare.

† Should be examined under oil-immersion phase-contrast microscopy.

measurements were taken from the centre of an imaginary line connecting anterior tips of epimeron fork to the centre of the posterior margin of the body.

(i) *Dorsum* : (Text-fig. 9). Number and distribution of setae on dorsum and venter

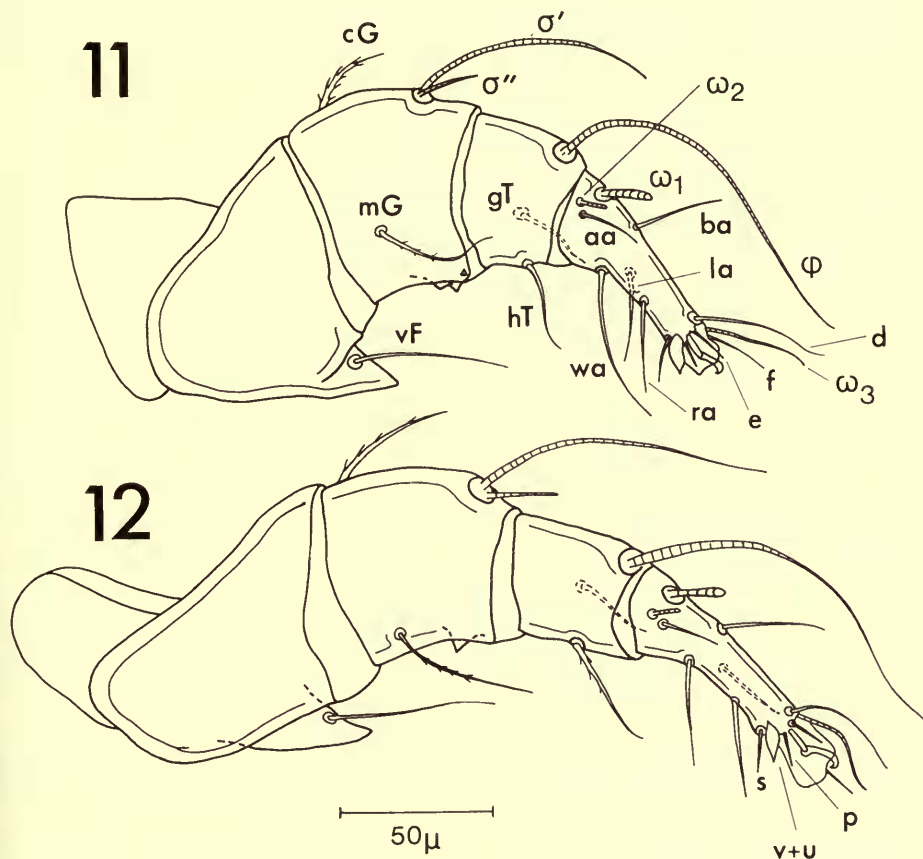


FIGS. 9, 10, 9, *Acarus nidicolous* sp.n. ♂. Idiosoma, dorsum. Specimen collected in Britain. 10, *Acarus nidicolous* sp.n. ♂. Idiosoma, dorso-lateral view. Unique specimen from U.S.A.

same as for *A. siro* complex, but degree of pectination different in that all hysterosomal setae are pectinate or, occasionally d_1 , hi and sometimes la may be smooth.

Length of dorsal idiosomal setae expressed as a percentage of idiosomal length (average of 5 individuals) are as follows: vi —17.2%, ve —4.9% sci —29%, sce —26%.

hi —10.9%, he —23.3%, la —10.1%, d_1 —8.6%, d_2 —23.7%, d_3 —24.6%, d_4 —19.2%, lp —16.0%, $sa e$ —13.5%, $sa i$ —31.4%. Thus, with the exception of $sa i$, the dorsal hysterosomal setae are longer than corresponding setae in the *Acarus siro* complex. In particular, d_2 and d_3 are over 20 per cent of the idiosomal length, so that when directed backwards in a straight line, the tips of d_2 extend beyond bases of d_3 and tips of d_3 extend just beyond or level with bases of d_4 .



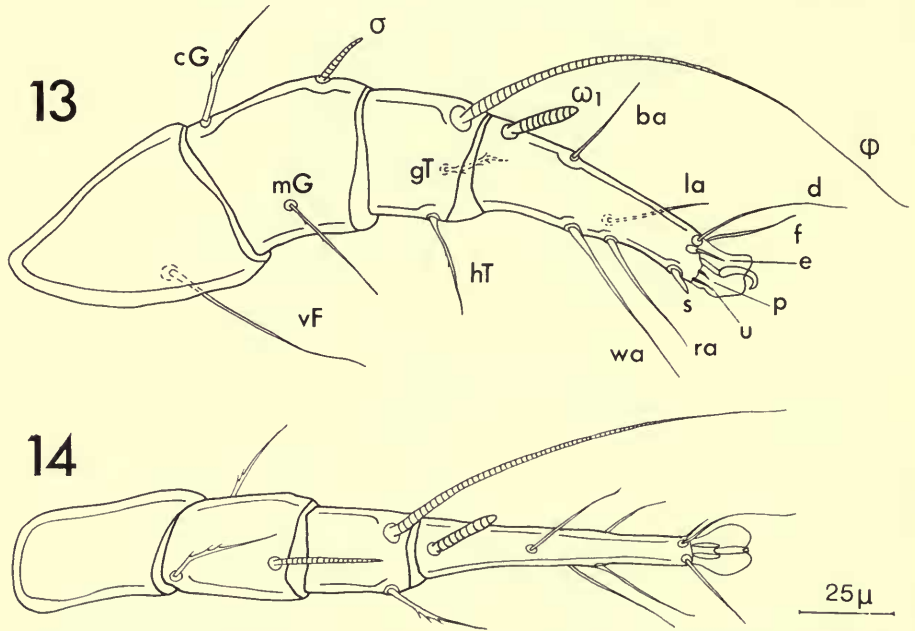
FIGS. 11, 12. 11, *Acarus nidicolous* sp.n. ♂. Leg I, post-axial face; structures labelled ω , σ and ϕ = solenidia; ε = famulus; remainder (e.g. aa , e , gT) = setae. 12, *Acarus nidicolous* sp.n. ♂. Leg I, post-axial face. Unique specimen from U.S.A.

Propodosomal shield similar in shape to that of *A. farris*. Grandjeans' organs, supra-coxal setae, not significantly different in shape from corresponding organs in *A. siro* complex. Electron scanning micrographs showing the structure of Grandjeans' organ and the supra-coxal seta of *A. siro* appear in Pl. IV, figs. 3 and 4, respectively.

(ii) *Venter*: Closely resembles ventral surface of males of the *A. siro* complex. Same complement of setae, smooth or at most with one or two pectinations. Position of post-anal setae relative to anal opening as for *A. siro* complex; their lengths relative

to each other also similar. No significant difference in structure of genitalia or apodemes.

(iii) *Legs: I & II.* Five segmented with well developed pre-tarsus terminating in a stalked claw. Genu and femur of leg I of ♂ much enlarged, femoral apophysis and genual projections as found in *A. siro* complex (Text-fig. 11). The chaetotaxy of leg II and the shape of solenidion ω_1 is described in Text-fig. 12. A micrograph of ω_1 on leg II is also shown in Plate II, fig. 3. In shape, it is relatively short, thick, and "cigar-shaped". Throughout its whole length it is thicker than the basal section of solenidion ψ of the tibia.



FIGS. 13, 14. 13, *Acarus nidicolous* sp.n. ♂. Leg II. 14, *Acarus nidicolous* sp.n. ♂. Leg II. Unique specimen from U.S.A.

(iv) *Morphological variation:*

Dr. Dean Furman presented me with a single ♂ specimen taken from the nest of *Neotoma fuscipes*, Wildcat Canyon, Alameda Co., California, U.S.A., June 1964. The length of the idiosomal setae of this specimen appears to be the same as for British males of *A. nidicolous* (compare Text-fig. 9 with 10). However, genu I bears only one large process instead of the usual two large and one small process (compare Text-fig. 11 with 12). These same figures illustrate that seta *hT* of leg I is smooth in British males but pectinate on the North American specimen. Also on genu II solenidion sigma of the North American specimen is much longer (compare Text-fig. 13 with 14).

Until further material can be obtained from the south-western areas of the United States, this specimen must be considered a variant of *A. nidicolous*.

FEMALE (Text-fig. 15). Body larger and more roundly oval than male.

(i) *Dorsum* : As for male, except that propodosomal setae, expressed as percentage of idiosomal length are slightly shorter, whereas the hysterosomal setae are longer, except *sa i* which is about the same in both sexes. The average lengths of idiosomal setae (from 5 females) are as follows:

vi—14.9%, *ve*—4.0%, *sc i*—24.5%, *sc e*—23.3%, *hi*—13.3%, *he*—24%, *la*—15.2%,

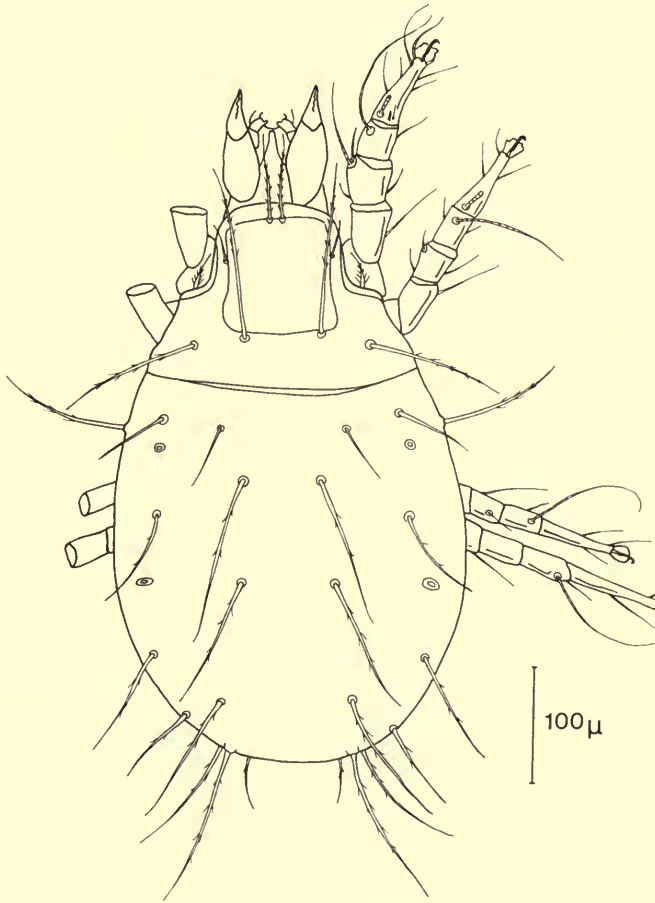


FIG. 15. *Acarus nidicolous* sp.n. ♀. Dorsum.

*d*₁—11.6%, *d*₂—25.2%, *d*₃—27.4%, *d*₄—23.3%, *lp*—22.3%, *sa e*—22.3%, *sa i*—31.0%.

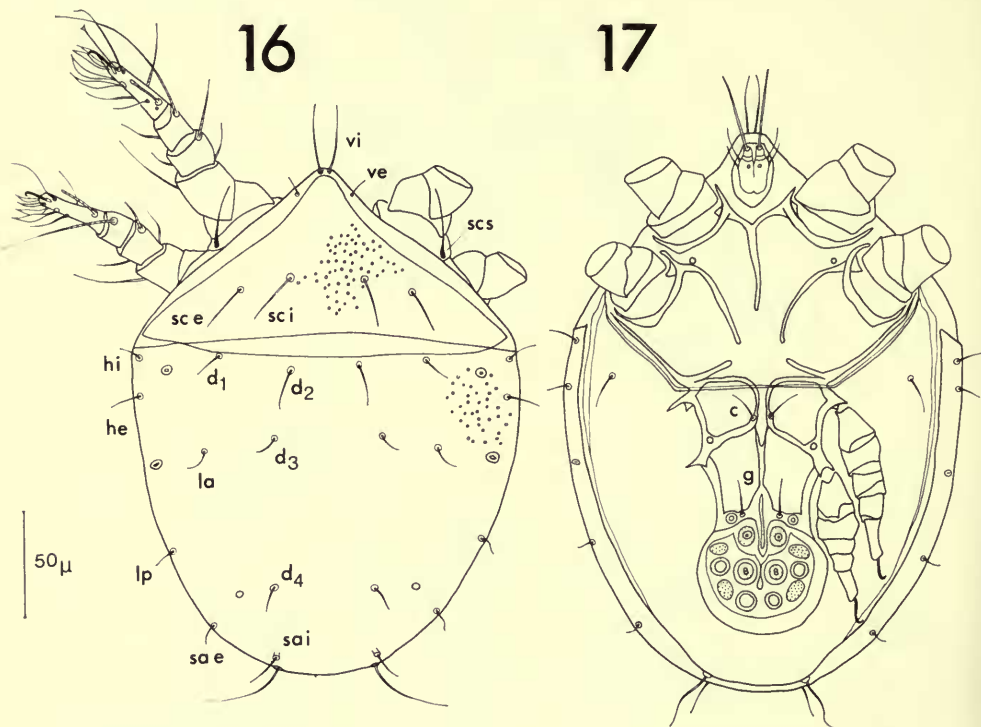
(ii) *Venter* : Morphology same as for *A. siro* complex females. Length of anal and post-anal setae, relative to each other, is very similar to that in *A. siro sensu stricto*.

(iii) *Legs* : Leg chaetotaxy and shape of solenidion ω_1 as for male.

HYPOPUS (Text-figs. 16 to 21). Colour of live specimens pinkish-beige. Gross

morphology the same as that of motile hypopi of the *A. siro* complex. Only the differences are given below.

(i) *Dorsum* (Text-figs. 16): Surface punctations smaller and not so dense. Setae *ve* almost smooth compared with dense pectinations of the same setae in the *Acarus siro* complex. All idiosomal setae are short, narrow and finely pointed. In particular, the four scapular setae (*sci* and *sce*) do not extend beyond posterior margin of the propodosomal shield. On extreme posterior margin a pair of setae, possibly homologous with *pa* are the longest pair on the hysterosoma.



FIGS. 16, 17. *Acarus nidicolous* sp.n. Hypopus. 16, Dorsum. 17, Venter.

(ii) *Venter* (Text-fig. 17): On gnathosoma, at base of each lobe which bears an arista, there is a small clear circular area which is not found in other motile *Acarus* hypopi.

Coxal skeleton much more defined. In freshly mounted specimens coxal fields III and IV can be seen to be enclosed. However, in older, permanent mounts those parts of the coxal skeleton which join apodemes III and IV and divide coxal fields IV fade, so that coxal fields III and IV may appear to be open. I have recently discovered that this phenomenon is true for other *Acarus* motile hypopi. Thus, the character "closed or open coxal fields" is not a reliable one to use in a taxonomic key.

The pair of genital setae (*g*) arise on a level with the anterior margin of the pairs of suckers which outflank them.

(iii) *Legs* : The four apical segments of legs I to IV are described in Text-figures 18 to 21.

LEG CHAETOTAXY OF ALL STAGES. Nomenclature follows Grandjean (1939).

The numbers of setae and solenidia on each segment of each leg of all stages is given below as a formula. The famulus (ϵ), which is present immediately in front of ω_1 on tarsus I in all stages is not included in the formula. The five groups of figures inside each parentheses represent, from left to right, tarsus, tibia, genu, femur and trochanter.

	Setae			
	Leg I	II	III	IV
Larva	(13.2.2.1.0.)	(12.2.2.1.0.)	(10.1.1.0.0.)	(-)
Protonymph	(13.2.2.1.0.)	(12.2.2.1.0.)	(10.1.1.0.0.)	(8.0.0.0.0.)
Hypopus	(9.2.2.1.0.)	(9.2.2.1.0.)	(8.1.1.0.1.)	(8.1.0.1.0.)
Tritonymph	(13.2.2.1.1.)	(12.2.2.1.1.)	(10.1.1.0.1.)	(10.1.0.1.0.)
Adult	(13.2.2.1.1.)	(12.2.2.1.1.)	(10.1.1.0.1.)	(10.1.0.1.0.)

	Solenidia			
Larva	(1.1.2.0.0.)	(1.1.1.0.0.)	(0.1.1.0.0.)	(-)
Protonymph	(2.1.2.0.0.)	(1.1.1.0.0.)	(0.1.1.0.0.)	(0.0.0.0.0.)
Hypopus	(2.1.1.0.0.)	(1.1.1.0.0.)	(0.1.0.0.0.)	(0.1.0.0.0.)
Tritonymph	(3.1.2.0.0.)	(1.1.1.0.0.)	(0.1.1.0.0.)	(0.1.0.0.0.)
Adult	(3.1.2.0.0.)	(1.1.1.0.0.)	(0.1.1.0.0.)	(0.1.0.0.0.)

The chaetotactic formula for *A. farris* given in Griffiths (1964) should be amended to agree with the above. This involves three alterations, namely:

(a) Protonymph setae, leg IV, tarsus I—replace figure 7 with an 8. I am now satisfied that spine *s* is present as a minute structure.

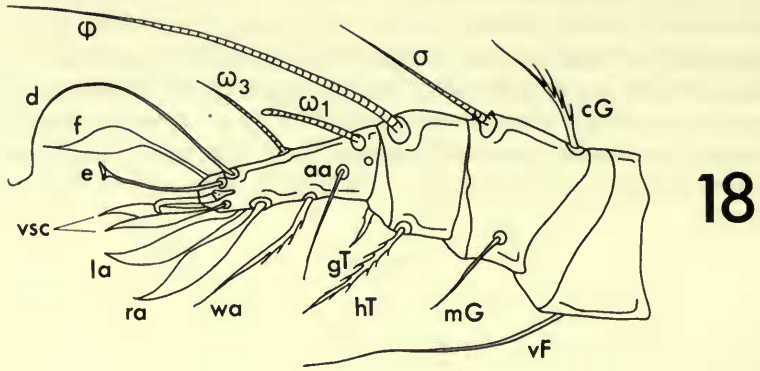
(b) Hypopal seta, leg I, tarsus I—replace figure 10 with a 9. Seta *ba* is NOT present.

(c) Hypopal solenidia, leg I, tarsus I—replace figure 1 with a 2. Solenidion ω_3 is present. In Griffiths (1964) it was mistakenly termed seta *ba*.

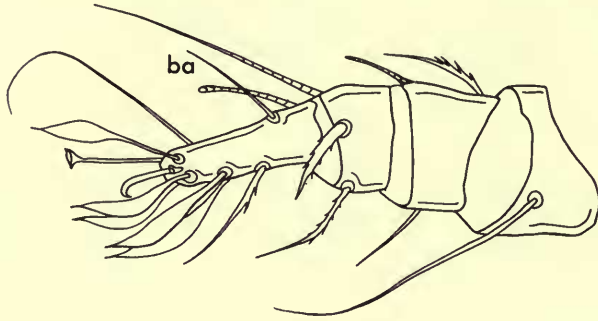
When the above corrections are taken into account, the chaetotactic formula for this species is identical with the formula for those species of the *A. siro* complex which have a motile hypopus. Also, the position of the respective setae and solenidia and, in general, their length and the degree of pectination of the setae are remarkably similar. However, as already mentioned, in adult specimens the shape of ω_1 is distinct.

BIOLOGY AND HYBRIDIZATION EXPERIMENTS. This species has been reared successfully in the laboratory for a period of four years. Single pair matings of virgin adults have been made to determine egg output and hatch. The pairs were reared in individual cells under the same physical conditions as the stock cultures namely, 20°C and 90 per cent relative humidity, with dried yeast powder as food.

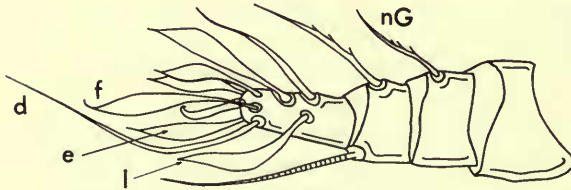
Twenty-five pairs laid 2044 eggs over a 15 day period. Maximum for any one pair



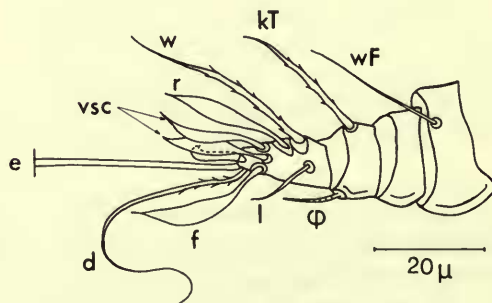
18



19



20



21

FIGS. 18-21. *Acarus nidicolous* sp.n. Hypopal leg chaetotaxy (excluding trochanter segment). 18, left leg I. 19, left leg II. 20, left leg III. 21, left leg IV.

was 137 and minimum 40, with an average per pair of 82. Percentage hatch was 85.9%.

The same technique as described above has been employed to cross *A. nidicolous* with the three species of the *A. siro* complex. Twenty initial crosses, in each direction were completed. Viable eggs were obtained only from the cross *A. immobilis* ♂ × *A. nidicolous* ♀. The results (Table 1) show that only 4 pairs produced eggs and

TABLE 1

Details of the four viable interspecific crosses
A. immobilis ♂ + *A. nidicolous* ♀

Pair number	Number of eggs per cross	% hatch	No. of offspring reaching maturity*	
			♀♀'s	♂♂'s
1	76	47.3	4	1
2	58	29.9	11	5
3	45	13.3	2	2
4	85	21.1	0	8

* F₁ crosses made with these adults failed to produce an F₂ generation.

indicate the presence of a reproductive isolating mechanism at the gamete level since each fertile pair produced very few offspring. With these offspring, 10 F₁ sibling and non-sibling crosses were performed. Seven crosses produced small numbers of eggs but none hatched.

DISTRIBUTION, HABITAT AND LOCALITY. Known from animal nests in Great Britain, namely; in unidentified small rodent nest, grounds of Pest Infestation Lab., Slough, Bucks., March 1964; breeding nest of hedgehog (*Erinaceus europaeus* L.), Pest Infestation Lab., Slough, Bucks., April 1964; squirrel drey, (*Sciurus carolinensis*), Wytham, near Oxford, April 1964; nest of hooded crow (*Corvus cornix*), Eileen mor, Inverpolly, Scotland, June 1964; mole (*Talpa europaea* L.) breeding nest, Foxfield, Wilts., January 1964; mole nest, Sittard. December 1911. Also from cheddar cheese, Slough, Bucks., 1967.

One ♂ from nest of *Neotoma fuscipes*, California, U.S.A., has also been assigned to this species (see p. 96).

MATERIAL DEPOSITED IN NATIONAL MUSEUMS

(i) British Museum (Natural History).

HOLOTYPE : ♂. England, Bucks., Slough; nest of unidentified small mammal in grass bank; March, 1964. Coll. D. A. Griffiths. BM(NH) registration number 1969.38

PARATYPES : Three ♂♂s, 6♀♀ and 3 hypopi, on 11 slides. BM(NM) registration numbers 1969.39 to 1969.41 inclusive. Data as for holotype.

OTHER MATERIAL : Three ♂♂, 1 ♀, 16 hypopi, on 5 slides. England, Oxfordshire, Wytham woods; *Sciurus carolinensis* nest (Grey squirrel's drey); April, 1964. Coll.

D. A. Griffiths. BM(NH) reg. numbers 1969.44 and 45 inclusive. One ♀, Scotland. Eileen mor, Inverpolly; *Corvus cornix* nest; June, 1964. Coll. G. E. Woodroffe. BM(NH) reg. number 1969.46.

One ♂, 2 hypopi, on 2 slides. England, Wilts., Foxfield; *Talpa europaea* breeding nest; Jan., 1964. BM(NH) reg. numbers 1969.47 and 48.

One ♀, 1 hypopus, on 2 slides. England, Bucks., Slough; *Erinaceus europaeus* breeding nest, April 1964. Coll. D. A. Griffiths. BM(NH) reg. numbers 1969.42 and 43.

(ii) United States National Museum (Washington).

PARATYPES : Four ♂♂, 6 ♀♀ and 3 hypopi, on 8 slides. Data as for holotype.

OTHER MATERIAL : USA, California, Alameda Co., Wildcat Canyon; *Neotoma fuscipes* nest, June 1st, 1964. Collrs. Chaniotis & Stumpf.

(iii) Institute of Acarology, Wooster, Ohio, U.S.A.

PARATYPES : Four ♂♂'s, 3 ♀♀ and 2 hypopi, on 7 slides. Data as for holotype.

(iv) Rijksmuseum van Natuurlijke Historie, Leiden, Holland.

OTHER MATERIAL : One slide bearing eleven hypopi. For data see item 2, page 114.

(iii) *Acarus macrocoryne* sp.n.

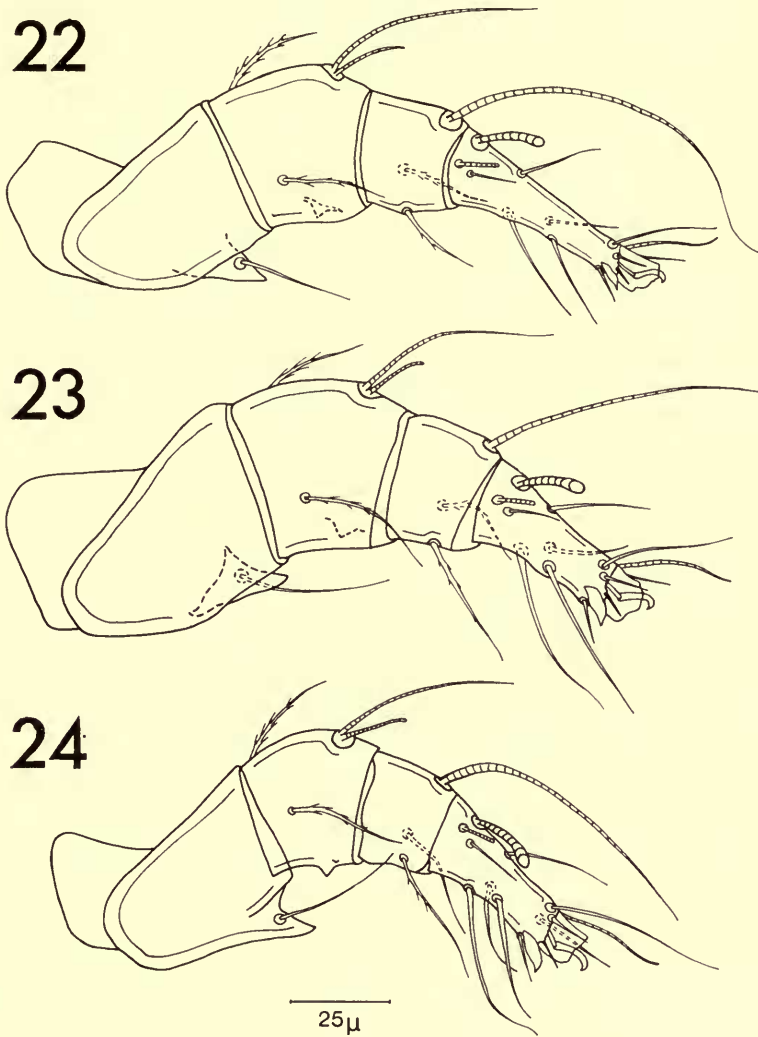
Previously, (Griffiths, 1964, p. 456), I referred this taxon to the category 'specimens *incertae sedis*'. The species is represented by two populations collected near Santa Fé, New Mexico, U.S.A. in 1952 and 1953. They were taken from two separate but similar habitats namely, the nests of the small mammals *Perognathus flavus* and *Dipodomys spectabilis*.

The mites from the *P. flavus* nest (36 specimens on one slide) are all very small and have short tarsi. The material from the *D. spectabilis* nest consists of specimens with similar short cylindrical tarsi together with others in which the tarsi are much longer, tapering towards the extremity (Text-figures 22, 23 and 24). Hysterosomal setae, *sc e*, *d*₂, *d*₃ and *lp* of long tarsi specimens also tend to be longer than the corresponding setae in the respective sexes of short tarsi specimens. The extremes of variation in length of hysterosomal setae shown by this population is illustrated in Text-fig. 5.

Since it has been shown (Griffiths, 1966) that tarsal length and shape can be influenced by varying the nutritional value of the food given to pre-adult stages, and because Text-figures 2 and 3 show that similar variations in setal lengths occur in *Acarus siro sensu stricto*, it is considered that the forms within the *D. spectabilis* nest population represent intraspecific variation.

MALE AND FEMALE (Text-figures 22 to 26 inclusive). Distribution and number of setae on the idiosoma is normal. Setae *he*, *d*₁ and *la* appear to be smooth in some "short tarsi" specimens, remainder are pectinate. Setae of "long tarsi" specimens with slightly more pectinations than "short tarsi" specimens. Because of the variation in length exhibited by the dorsal setae of the idiosoma, the lengths of these setae relative to body length is not given, but are adequately illustrated in the accompanying text-figures. In general, the lengths of the dorsal setae *d*₂, *d*₃ and *d*₄

may be used with discretion to distinguish this species from members of the *A. siro* complex. Where populations are represented by single specimens or a few individuals this character may not in itself be conclusive.



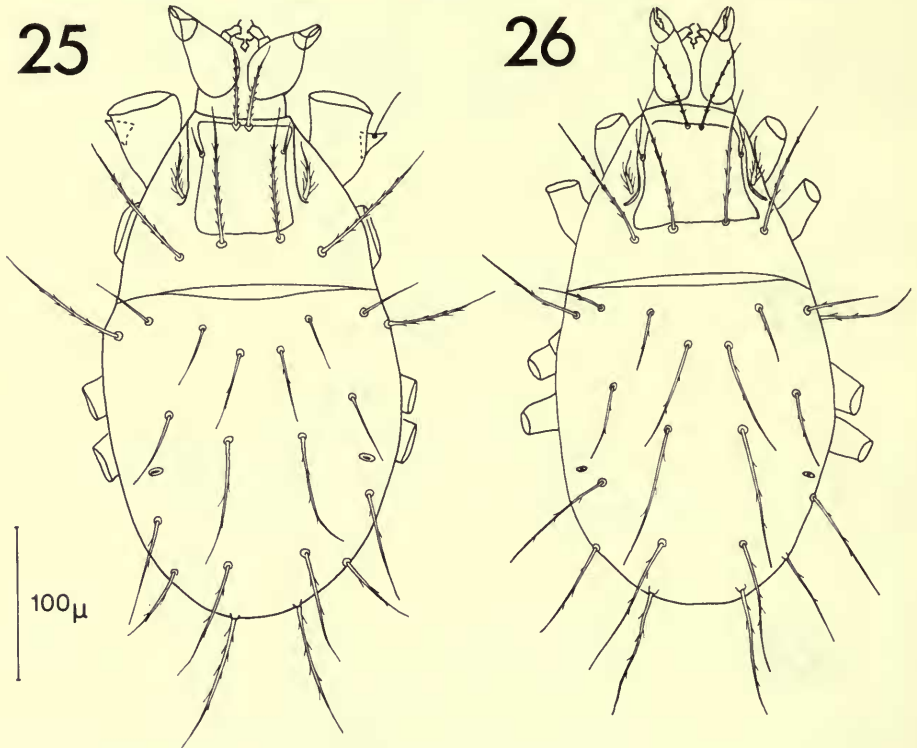
FIGS. 22-24. *Acarus macrocoryne* sp.n. Leg I chaetotaxy and tarsal length variation. 22, a "long tarsus" specimen ex *D. spectabilis* nest. 23, a "short tarsus" specimen from the same population. 24, leg I of specimen from a population found in the nest of *Perognathus flavus*. The whole population has very short tarsi.

Remaining features of the idiosoma not significantly different from those of the *A. siro* complex.

Genu and femur of leg I of the male much enlarged as usual but the projections

on the genu are reduced to one large tooth and sometimes a minute sub-tending tooth, compared with the two large and one small projection found on genu I of the males of *Acarus* species described previously.

LEG CHAETOTAXY (Text-figures 22 to 24). Position, length and, where applicable, the degree of pectination of setae not significantly different from that described for the *A. siro* complex.



FIGS. 25, 26. *Acarus macrocoryne* sp.n. dorsum. 25, ♂. 26, ♀.

Solenidion ω_1 on tarsus I and II is long, slightly curved, expanding towards the apex into a distinct head. The internal margin of the head is more expanded than the external margin (Pl. II, Fig. 4).

The famulus is minute and difficult to discern even under oil-immersion phase-contrast microscopy.

MATERIAL DEPOSITED IN NATIONAL MUSEUMS.

(i) United States, Washington.

HOLOTYPE : on slide with data as given below I select the male specimen which bears long setae. The position of the holotype specimen is indicated by a labelled diagram attached to the slide. It is the second specimen in from the right-hand edge of the cover-slip as viewed through a stereoscopic binocular microscope and

the second from the left as viewed through a compound microscope. There are another 3 ♂♂ and a nymph on the slide, these 4 specimens constitute paratypes.

Data : USA, New Mexico, Santa Fé; *Dipodomys spectabilis* nest 63A ; Feb. 2nd, 1953. Coll. H. B. Morlan.

PARATYPES : Three ♀♀ on one slide, with same data as for holotype.

Twenty ♂♂s and 16 ♀♀s, on one slide. USA, New Mexico, Santa Fe; *Perognathus flavus* nest ; Feb. 29, 1952. Coll. H. B. Morlan. USNM reg. number Lot 52-11181.

(ii) British Museum (Nat. Hist.)

PARATYPES : Single ♂ and 2 ♀♀, on 2 slides. Data as for holotype. BM(NH) reg. numbers 1969.51 and 52.

(iv) *Acarus chaetoxsilos* sp.n.

In Griffiths, 1964 this taxon was not given specific rank because at the time it was known from two specimens only. These were imported into the United States of America from Japan on *Citrus* sp. More recently, in a collection of *Acarus* material kindly loaned by Dr. D. E. Johnston, Institute of Acarology, Ohio, U.S.A., I found another male which was also introduced from Japan into the U.S.A. But, on this occasion, the cargo was "Irish" potatoes and the time interval separating the two collections is twelve years.

MALE AND FEMALE

(i) *Idiosoma* (Text-figures 27, 28). General body conformation same as that described for other *Acarus* species. Genu I of male bears two strong teeth and one smaller projection as in *A. nidicolous*. Spine *s* angled forward and about half length of tarsal claw. (See pl. IV, fig. 2 for example.)

On the idiosoma the vertical internal setae (*vi*) are pectinate but, except for a single pectination on some of the scapular setae, the remaining setae are smooth, long and whip-like, tapering so finely towards their tips that only when viewed by oil-immersion phase-contrast equipment can their full length be seen. Setae *hi* and all setae of the dorsum posterior to *d*₂ are exceptionally long, resembling the posterior train of setae of *A. tyrophagoides* but different from this species because the internal scapulars (*sa i*) are long. The terminal portion of the supra-coxal seta is also extended into a fine tapering thread.

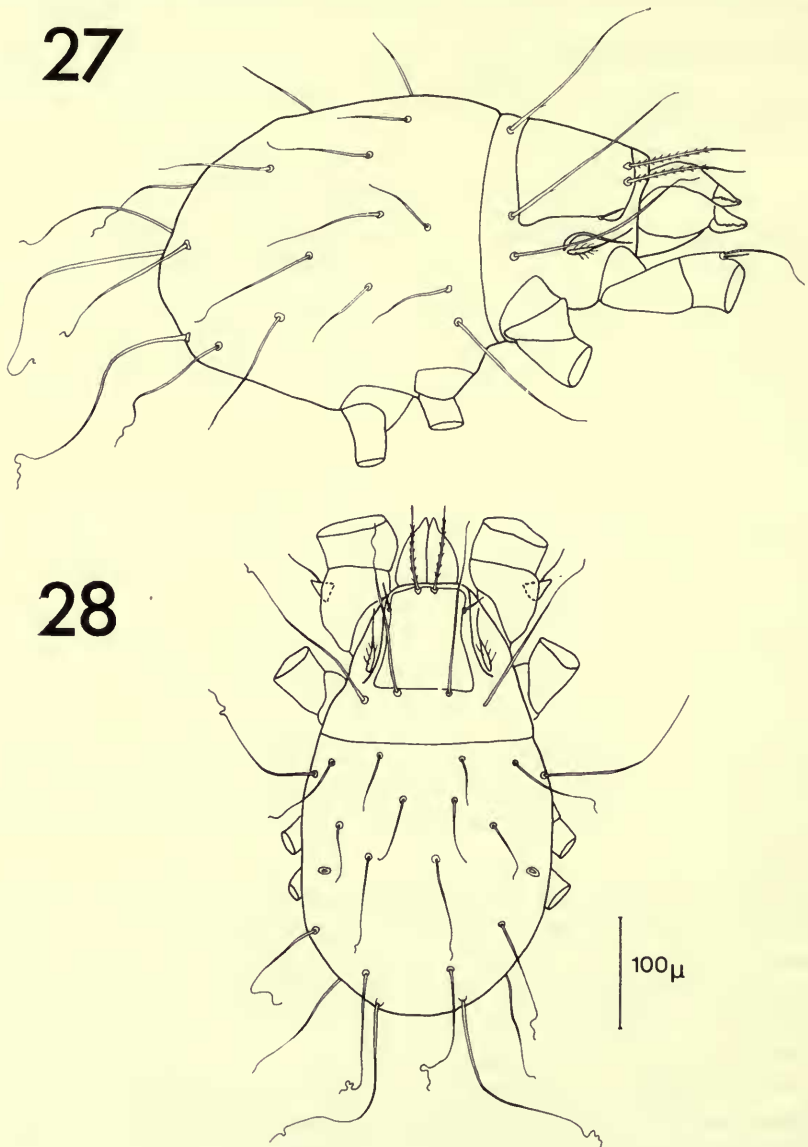
(ii) *Legs* (Text-figures 29, 30). The glabrous setae of the tarsi are also long with fine whip-like endings. Setae of the tibia and genu are pectinate as for other species.

On tarsus I and II ω_1 is fairly short, evenly cylindrical from the base until just before the apex, where it expands almost imperceptibly into a poorly defined head (Pl. III, fig. 2). It is similar in shape to ω_1 of *A. nidicolous*. The trivial name has been derived from *chaeta*, hair; *xysilos*, shaven.

HOLOTYPE : I select as holotype the ♂ specimen on United States National Museum slide number 40.21938. There is one ♀ paratype of the same taxon on the same slide. Data : On *Citrus* sp., Japan, at Seattle, Washington, October 10th, 1940. Seattle No. 9081.

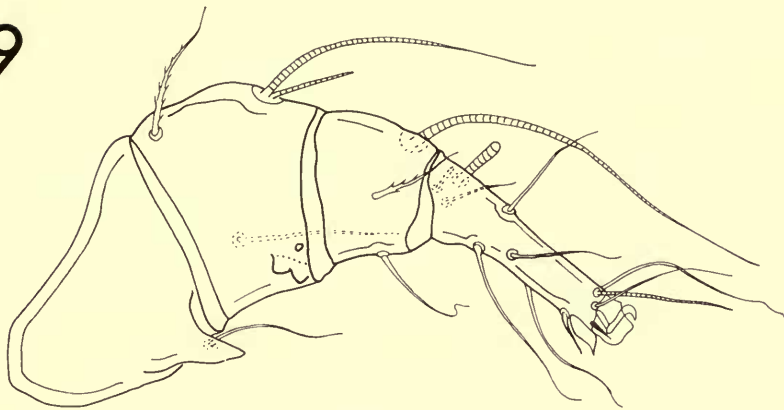
PARATYPES : In addition to the ♀ mentioned above, there is one ♂ (together on

same slide with a number of ♀♀ which are not of this taxon) with the following data :
" Irish " potatoes, Japan : at Boston, February 28th, 1956; Collr. Lantz & Averill,
Lot 56 ; 3105. In the collection of the Institute of Acarology, Columbus, Ohio,
U.S.A.

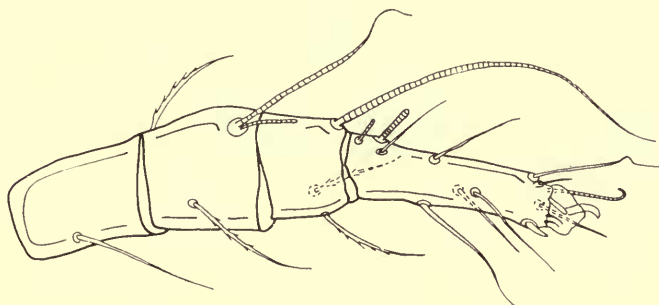


FIGS. 27, 28. *Acarus chaetoxsilos* sp.n. 27, ♀ dorso-lateral view. 28, ♂ holotype, dorsum.

29



30



50μ

FIGS. 29, 30. *Acarus chaetoxysilos* sp.n. Leg I chaetotaxy (excluding trochanter segment).
29, ♂. 30, ♀.

(v) *Acarus calcarabellus* sp.n.

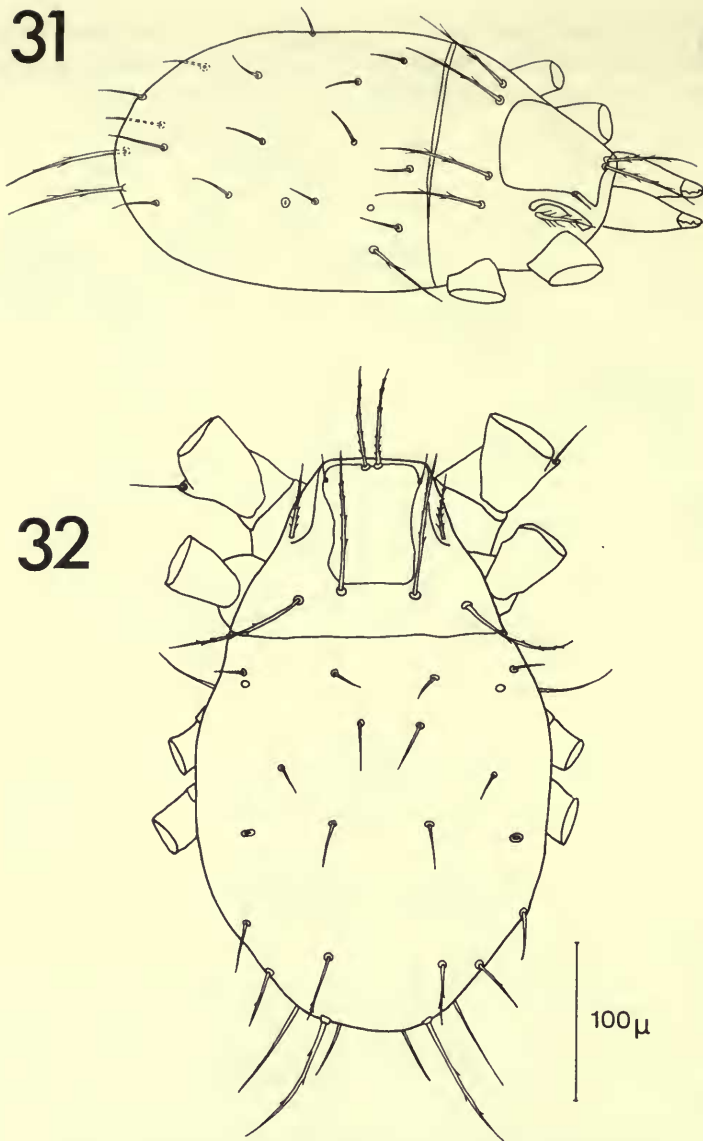
MALE AND FEMALE (Text-figs. 31 to 36).

(i) *Idiosoma*. The general body conformation is the same as that described for other *Acarus* species. However, it should be noted that in all specimens the idiosomal setae are very short and sparsely pectinate (Text-figs. 31 and 32).

(ii) *Legs*. Genu I of ♂ is devoid of all protruberances and the spur on femur I is reduced so that seta *vF* arises very close to the tip of the spur. When viewed from some angles it appears to arise directly from the tip. The structure of genu I and femur I serves to distinguish the male from males of all other known species in the genus (Text-figs. 33 and 35).

The shape of solenidion ω_1 on tarsus I and II in both sexes is distinct (Pl. II, fig. 2). It is relatively long, especially on tarsus II, and a little more slender than ω_1 of previously described species. Well before the apex, it expands slightly to form a long lozenge-shaped club, best observed when the solenidion on tarsus II is viewed laterally.

A population consisting of 3 females and a single male was given to me by Dr. van Eynhoven, who commented upon the unusual shape of the male spur. I took



FIGS. 31, 32. *Acarus calcarabellus* sp.n. ♂. 31, ♂ ex cheese, dorso-lateral view. 32, ♂ ex *Erithacus rubecula* nest.

another small population from the nest of a robin (*Erithacus rubecula*) where it was in association with *A. farris*.

HOLOTYPE : ♂. England, Berks., Ascot; *Erithacus rubecula* nest, box no. DAG/70; Feb., 1966. Coll. D. A. Griffiths. BM(NH) reg. number 1969.49.

PARATYPES : the following are in my collection ; one slide bearing single ♂, data as for holotype, two ♀♀ and one ♂ on three slides, data—Holland, 1964; ex kaas [cheese].

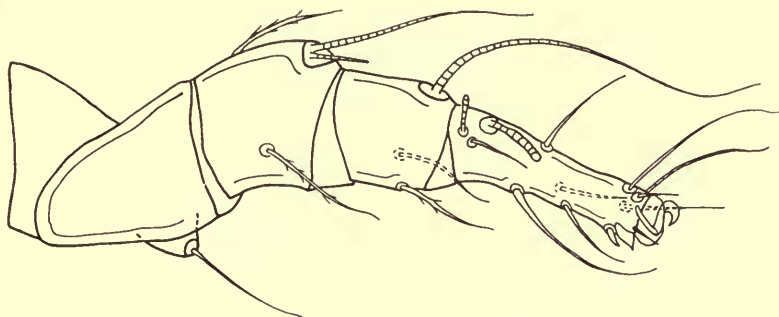
6. SPECIMENS INCERTAE SEDIS

- (i) *Acarus* population ex *Citrus grandis* fruit, Formosa, imported into U.S.A., Oct. 8th 1956.

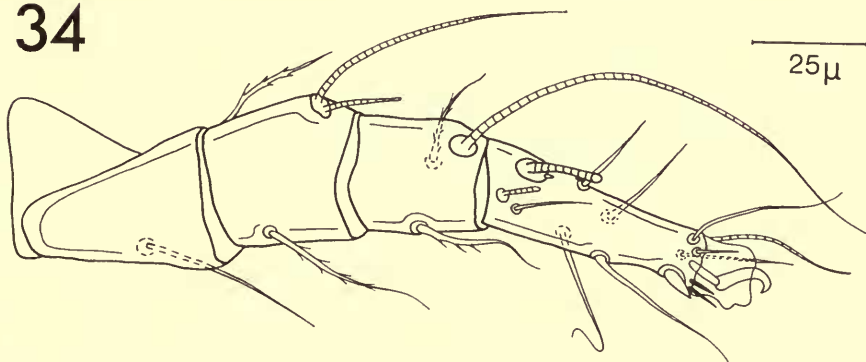
This taxon is known from two females and nine nymphs on one slide. Data ; United States National Museum number 56-12672, on *Citrus grandis* fruit, Phila. Pa. October 8th 1956, J. Freedland Colr.

The females are distinguishable from *A. immobilis* only in as much as firstly, the dorsal setae d_2 to d_4 inclusive are longer than the corresponding setae representing the

33



34



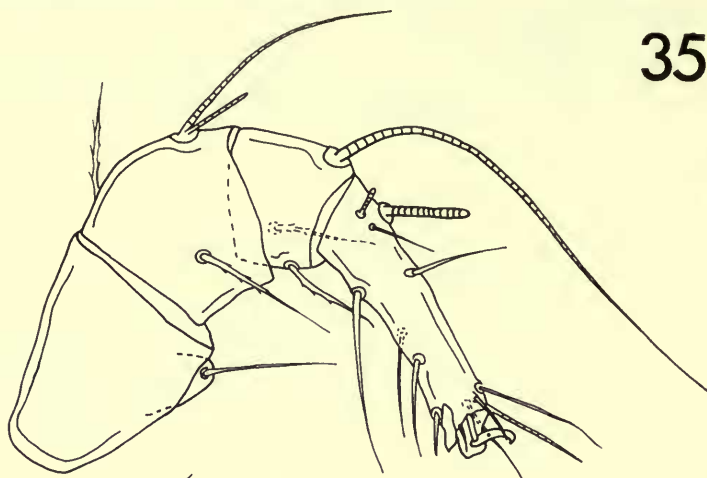
FIGS. 33, 34. *Acarus calcarabellus* sp.n. Leg I chaetotaxy. 33, ♂; note absence of genual processes and small femoral spur. 34, ♀.

extremes of variation observed in *A. immobilis* (Text-fig. 37). Secondly, solenidion ω_1 , although similar in shape to ω_1 of *A. immobilis*, has a much more slender shaft. (Pl. III, fig. 4).

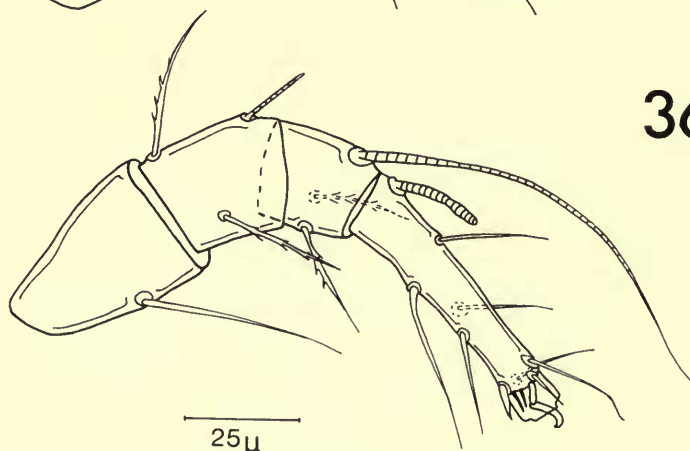
Plate I, fig. 1 and 2 illustrates that ω_1 of *A. immobilis* can vary in thickness. It is also true that setal length is variable. Therefore, the Formosan specimens may represent an extension of the variability already observed in populations from Europe and the Near East. Until such time as further populations become available from the Far East, these specimens must remain *incertae sedis*.

(ii) *Acarus* population ex cocoanuts, Brazil, imported into U.S.A., 1935.

One ♂, one ♀ and a tritonymph were taken from cocoanuts imported into San Francisco, from Brazil on July 7th, 1935. Coll. F. J. Phelan. U.S. National Museum collection, San Francisco number 5368.



35



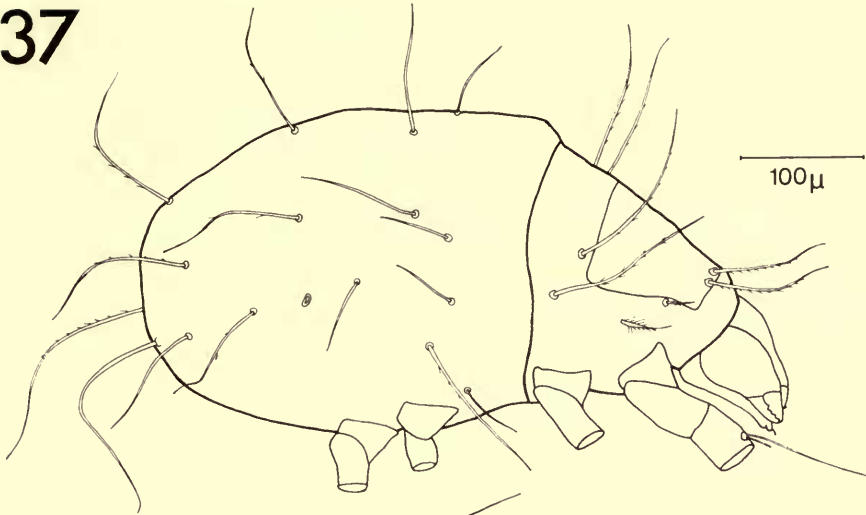
36

FIGS. 35, 36. *Acarus calcarabellus* ♂ holotype. Leg chaetotaxy (excluding trochanter segment). 35, leg I. 36, leg II.

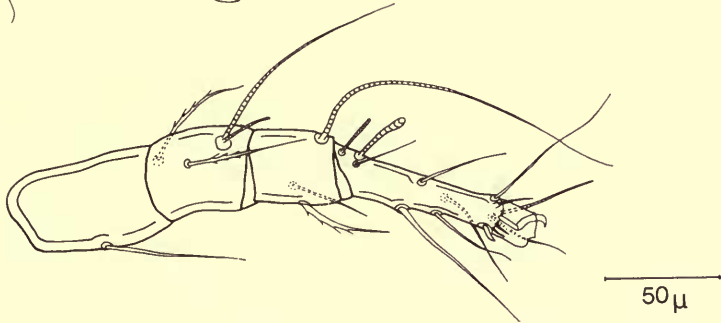
FEMALE (Text-fig. 39) : Dorsal hysterosomal setae relatively long, with d_2 and d_3 reaching or overlapping bases of next distal pair of setae. Scapular setae each bears five or more sets of pectinations but *all* setae of the hysterosoma are glabrous with fine endings. The supra-coxal setae are long and slender, bearing only seven pectinations (Text-fig. 39). Solenidion ω_1 has a shape which closely resembles that found in *A. immobilis* (Pl. III, fig. 3).

MALE : Represented by one poor specimen. Genual processes and tibial spur

37



38



FIGS. 37, 38. *Acarus* specimen. *incertae sedis* ex Formosan *Citrus grandis* fruit. 37, ♀ lateral view. 38, leg I of same ♀.

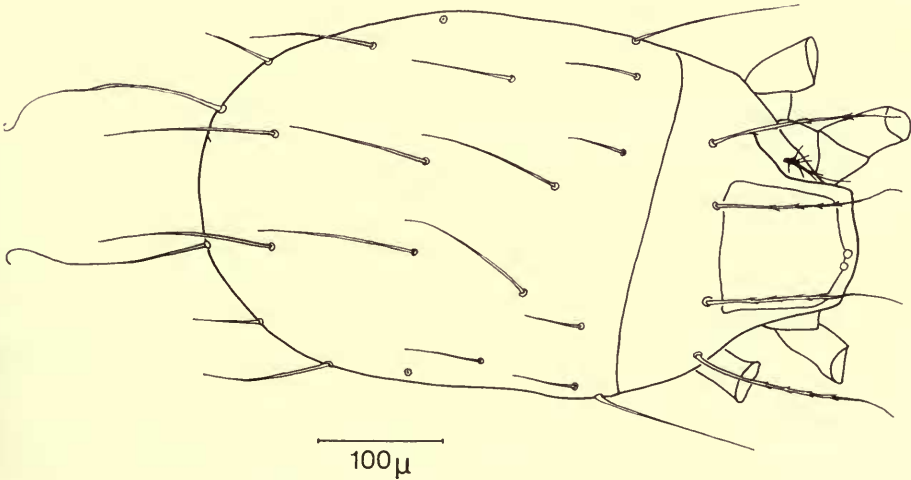


FIG. 39. *Acarus* specimen *incertae sedis* ex Brazilian cocoanut. ♀, dorsum.

normal. Idiosomal setae as for female except d_4 and $sc\ e$ each bear two pectinations. Only one supra-coxal seta on specimen, this bears only four, long, slender pectinations. Solenidion ω_1 as for female.

TAXONOMIC POSITION: This taxon combines the distinguishing characters of a number of the species described above. Solenidion ω_1 is similar in shape to ω_1 of *A. immobilis* (compare Pl. I, fig. 2 with Pl. III, fig. 3). However, the hysterosomal setae are too long and devoid of pectinations for it to be considered conspecific with *A. immobilis*.

The glabrous nature of the hysterosomal setae puts it close to *A. chaetoxysilos* and to the specimens *incertae sedis* ex China (see below). The long, slender, sparsely

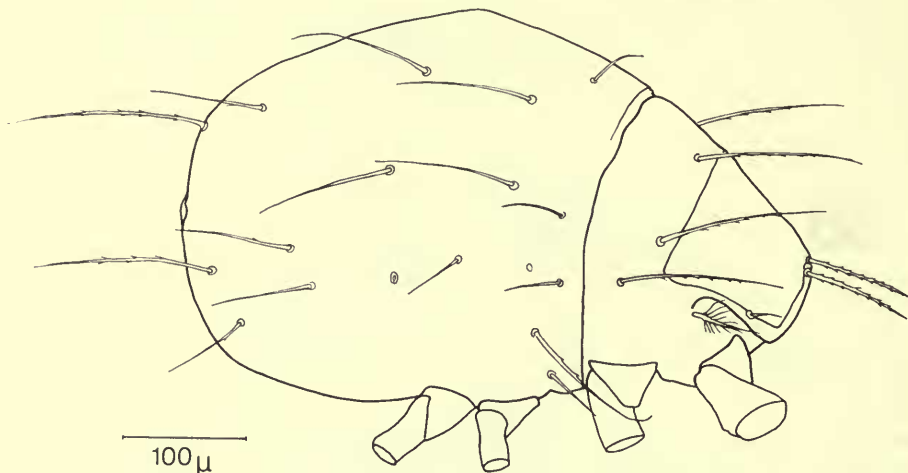


FIG. 40. *Acarus* specimen *incertae sedis* ex Chinese water-chestnuts. ♀, dorso-lateral view.

pectinated supra-coxal seta serves to distinguish it from both of these taxa. Since all the characters cited above are known to exhibit intra-specific variation, it is considered that the taxon be placed as specimens *incertae sedis* until further material becomes available.

(iii) *Acarus* population ex Chinese water chestnuts,
imported into U.S.A., Jan. 22nd, 1937.

The taxon is represented by one ♂ and ♀ on U.S. National Museum slide number 37-2183. One other female, not an *Acarus*, is also mounted on the slide. The material was imported from China into Chicago.

The specimens are close to *A. immobilis* but the dorsal setae are longer and less pectinate than those of *A. immobilis* populations examined to date (Compare Text-fig. 4a with 40).

7. RE-ATTRIBUTION OF MATERIAL LISTED AS SPECIMENS *INCERTAE SEDIS* IN GRIFFITHS 1964 (pages 453 to 457).

These were catalogued under the country from which they probably originated although some were collected at quarantine centres in the U.S.A. I shall re-list them as first published.

(i) BRAZIL (on orange navel end). Since I am now satisfied that in *A. immobilis* the dorsal idiosomal setae d_2 , d_3 and d_4 may be longer than given in my original description, I place this specimen in *A. immobilis*.

(ii) NEW ZEALAND. Now considered to represent hybrids of the cross *A. siro* × *A. immobilis*.

(iii) FORMOSA. Remains as specimens *incertae sedis* (see p. 109).

(iv) JAPAN. Given specific rank in this paper (see p. 105).

(v) AZORES ♀ AND KENYA ♀. These were originally thought to represent intra-specific variation in *A. siro*. On the evidence illustrated in Text-figs. 2 and 3, I am now convinced that this is correct.

(vi) CHINA. Still placed as *incertae sedis* (see p. 112).

(vii) U.S.A., NEW MEXICO. Raised to specific level (see p. 102).

8. AN APPRAISAL OF THE *ACARUS* SPECIMENS CONTAINED IN THE OUDEMANS COLLECTION, RIJKSMUSEUM VAN NATUURLIJKE HISTORIE, LEIDEN.

I am most grateful to Dr. Van der Hammen of the Rijksmuseum van Natuurlijke Historie, Leiden, who kindly loaned the material in the Oudemans collection appertaining to the genus *Acarus*. Namely; slides labelled *Tyroglyphus farris*, *Tyroglyphus farinae* and *Tyroglyphus africana*. The mounting medium on many of the slides has deteriorated but the important morphological characters of most specimens can be resolved with phase-contrast equipment. This most interesting collection has been examined and specimens have been determined to species level according to the information obtained from my investigations into the genus *Acarus*.

(i) Material labelled *Tyroglyphus farris* Ouds.

It consists of seven slides representing material collected from three localities. The label on the left side of each of the slides has been crossed through by two pencil lines. Buitendijk (1945), in her catalogue to Oudemans' collection, states that the word 'fout' (error) is written on the drawings of *farris*, but the reason for this is unknown. I believe that Oudemans crossed through the slide labels and wrote 'fout' on his drawings when he decided, in 1925, that *farris* was a race of *farinae* and not a discrete species.

The left label of each slide bears the word 'type' (in ink) in Oudemans' handwriting. Since his original description of *farris* is based on material which he collected at Arnhem in 1902, I have previously selected as lectotype the single male specimen mounted on the slide numbered 45 (Griffiths, 1962). Details of the slides are as follows: Catalogue numbers 43 and 44 :- Utrecht Sept., 1885. One chelicera and part of a gnathosoma is mounted on slide 43, which is in poor condition. Slide 44 con-

sists of seven females, all of which are identifiable as *Acarus farris*. The habitat is not recorded. Catalogue numbers 45, 46 and 47 :- Arnhem February 1902; taken from cheese. The cover-slip of slide 45 is crazed but the diagnostic characters of tarsus II of the single male are plainly visible under a phase-contrast microscope (mag. $\times 800$). Slides numbered 46, 47 and 48 are not in very good condition. They bear, respectively, single specimens of the tritonymph, protonymph and larva.

Catalogue number 49 :- Arnhem March 1909, *Mus decumanus*. The cover-slip is crazed and the seven tritonymphs mounted on the slide have shrivelled.

(ii) Material labelled *Tyroglyphus farinae* L. 1758.

It consists of twenty-seven slides (catalogue numbers 1 to 27), representing twenty-one collections made between 1898 and 1932 by various people. Details of these slides are listed below in the following manner :

Slide number :

L = Inscription on left label ; since the words '*Tyroglyphus farinae* L. 1758' appears on each label, they have not been repeated each time in the following notes.

R = Inscription on right label ; generally a record of date of collection, habitat, location and collectors' name.

This information is followed by my determination of the specimens on the slide, where this is possible, and remarks when necessary.

1. L. Female ds. ve.
R. Zuid Willems-varrt Brabant 9.viii.1918. Dr. G. Romyn prep. no. 196.
Two females both of which are *A. siro*.
2. L. Nph II. hypop. Kortharig ras.
R. Nest van *Talpa europaea* L. Sittard 12. 1911 F. Heselhaus. Eleven motile hypopi of *A. nidicolous* sp.n. Oudemans' comment 'Kortharig ras' [short-haired race] refers to the short scapular and dorsal setae peculiar to this hypopus.
3. L. Nph II hypopialis vent.
R. *Cucumis melo* en sativa. Zwynndrecht 20.5.1922.
Institut v. Plantensiekten Wageningen.

The morphology of dorsal and ventral surface of this single motile hypopus is extremely similar to that of an F₁ hybrid motile hypopus resulting from the cross *farris* \times *immobilis*.

4. R. op Kass, Rykszuivel station Leiden ; Dr. van Sillers Edt.
Eight specimens, comprised of a mixed population of *siro* and *farris*.
Taken from cheese, State Dairy Produce Station, Leiden, Holland.
- 5 and 6.
R. Hyacinthebol, Sassenheim Febr. 1924.
F. Schoevers Wageningen don.
Slide 5 is of nine males and slide 6 bears twenty-four females. This material represents a mixed population of *farris* and *immobilis*. Twelve of the specimens are *immobilis*, six are *farris*, nine appear to be hybrids and six I cannot identify because it is impossible to obtain a lateral view of solenidion ω_1 .

7. R. Insecten collectie Amsterdam, 1916. MacGillavry.
Sixteen hypopi (possibly taken from an insect specimen by MacGillavry). This slide is in a very poor condition. I can identify eight specimens as *farris* but the remainder cannot be identified.
8. L. Nph I dors. vent. lat.
R. in grutterswaren, Keuringsdienst Amsterdam. Oct., 1923.
Three protonymphs which judged on the size of spine S, are *siro*. Translation of details on right label is: 'in corn-chandlers wares, Inspection Service, Amsterdam'.
9. L. Male dors. vent. normal gebouwd ras.
R. Arnhem 27 Mei, 1898 Oudemans.
A very poor slide bearing two males which I believe are *A. siro*, but the specimens are too obscured to be absolutely certain. These specimens represent Oudemans' 'normal born race' in his discussion of races (Oudemans Feb., 1924).
10. L. Protonympha dors. vent.
R. op veegsel meelmager Arnhem 2.2.1902 Oudemans.
Five protonymphs, all *siro*; collected by Oudemans from old flour sweepings.
11. L. Nymph II hypop. dors. mooi exemplar 258.
R. *Mus rattus* L. Arnhem 8.10.1904. Oudemans.
This is a hypopus of *A. farris*.
12. L. male, zeer sterk ontwikkeld ras.
R. *Cavia cobdya*, Arnhem Feb. 1909 Oudemans.
One male *A. farris*. Translation of note on left label reads :- 'very strongly developed race'. Oudemans (Feb., 1924) gave this male as an example of a strong race having dark coloured legs. But, differing from other strong races in that tarsi of legs II, III and IV were long and slender; as long as the genu and tibia together. It is interesting to note that Oudemans did not recognise this specimen as *farris*.
13. L. nymph. female, male.
R. in een gat in een appal. Arnhem 17-III-1918 Oudemans.
Three specimens too poor to be identified, together with one male which is *farris*. They were taken from a hole in an apple.
14. L. groot ras.
R. auf Kase, Bremen 16.9.1904 F. Koenike coll.
One male, one female, both *farris*. Oudemans (Feb., 1924) gave these as an example of a strong race which had shorter tarsi than the male on slide 12.
- 15 and 16.
L. 15- hypopi uit Nph I gekweekt
16- Nph II uit hypopi gekweekt.
R. Berlyn 14.5.1923, Hanna Schulze.
Slide 15 bears 8 motile hypopi of *A. farris* which emerged from protonymphs and slide 16 is of 3 tritonymphs which emerged from hypopi.

But, since I am unable to distinguish between nymphs of *farris* and *immobilis*, I cannot be certain to which species the tritonymphs belong.

17, 18 and 19.

R. Shag-tabak, Hamburg, Feb., 1928. Dr. L. Reh, visit.
Three slides, totalling fifteen females and one male; all are *A. siro*.

20. R. op vorkens-dormen Berlyn Aug. 1927. Dr. F. Zacher.
Twelve specimens all identifiable as *A. Siro*.

21 and 22.

L. Lv, Nph I, III, adulti.

R. *Evotomys glareolus*. Schreber Hemmelsdorper See. 10.4.1926 Erna Mohr.

There are over one hundred and fifty specimens on slide 21, which is not very clear. All the specimens which can be identified are *A. siro*. The single hypopus on slide 22 is definitely an *Acarus siro*. It is the only one in the whole collection. Presumably, these specimens were taken from the nest of a bank vole.

23. L. Printed label ACAROTHECA I-9 *Aleurobius farinae* (D.G.)

R. Printed label ITALICA. In farina, caseo, etc., Italia septentre. A. Berlese.

One male and one female. The male is an *Acarus farris* and the female is an *Acarus siro*.

Berlese used to make slides which he then sold to institutions and private collectors. Slide 23 is undoubtedly an example of this work. To each slide of any one species Berlese attached printed labels. The right-hand label of each was inscribed with identical information concerning the habitat of the species. Usually, this information was of a general nature, giving the habitat in which Berlese believed the mite was most commonly found. In this case he gave 'in farina, caseo, etc.'. Since it is possible the mites may have been collected from some other habitat, this data is not necessarily true for these particular specimens.

24 and 25.

L. Nympha.

R. Steelgrove *Citrus aurantium* Zind Europa. Arnhem, Oudemans II, 1932.

Both slides have been re-mounted. I failed to find any specimens on either slide!

26. L. Nph II hyp. dors. vent.

R. *Osmoderma eremita* Scop. Weenen Aug., 1924.
H. E. Wickmann, legit Vitzthum donavit.

One hypopus of *A. farris* which presumably was taken from *O. eremita* (a species of the flower-beetles).

27. R. in een buisje met *Hevea* parasieten; Medan, Deli Proepstation AVROS Mei, 1918.

Two males, one is *siro*, the other specimen is crushed and cannot be identified. Translation of words on right label reads—'in a tube with *Hevea* parasite, Medan, Deli Agricultural Research Station'.

(iii) Material labelled *Tyroglyphus africana*

This consists of one slide labelled as follows:

Catalogue no. 1,

L. *Tyroglyphus africana* (Oudms) female, dors *type*.

R. *Platygenia barbata* (Cetonide) Togo (W. Afr.)

H.Voigts 10.ix.1901.

A single female which is undoubtedly an *Acarus siro*, placed in synonymy in Griffiths 1964.

9. SUMMARY

Ten species taxa are recognised; four are described for the first time, two of which were previously considered as specimens *incertae sedis*. A key to adults is provided.

Generic characters together with interspecific and intraspecific variation are reconsidered. An appraisal is made of the *Acarus* specimens contained in the A. C. Oudemans collection, Rijksmuseum van Natuurlijke Historie, Leiden.

10. ACKNOWLEDGEMENTS

I am most grateful to the many acarologists who were sufficiently interested in my first revision of *Acarus* to send me material which they considered to be unusual, and which I have subsequently used as the basis of this new study. I am particularly indebted to Dr. E. W. Baker, United States National Museum, Washington, Dr. E. van Eynhoven, Zoological Museum, Amsterdam, Dr. D. Furman, Division of Parasitology, University of California, Dr. D. Johnston, Institute of Acarology, Ohio State University, and Dr. W. Knulle, Acarology Laboratory, Department of Zoology and Entomology, Ohio Agricultural Research and Development Centre. I am most grateful to Dr. L. van der Hammen, Rijksmuseum van Natuurlijke Historie, Leiden, for the loan of Oudemans' material.

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PLATE I

Lateral view of solenidion ω_1 (ω_1) situated on tarsus II. $\times 2250$

FIGS. 1 & 2. *Acarus immobilis* Griffiths.

FIG. 3. *Acarus gracilis* Hughes.

FIG. 4. *Acarus siro* L.

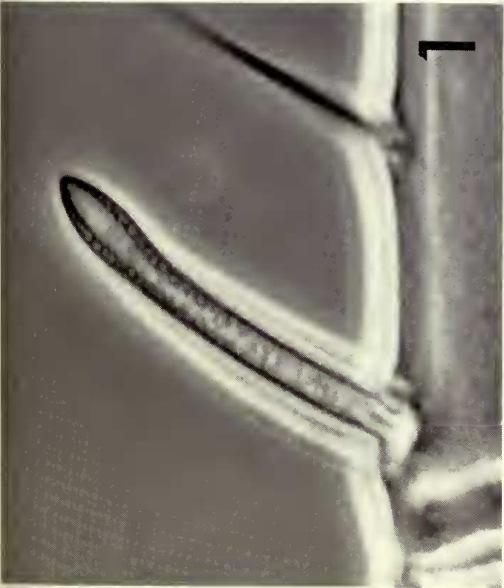
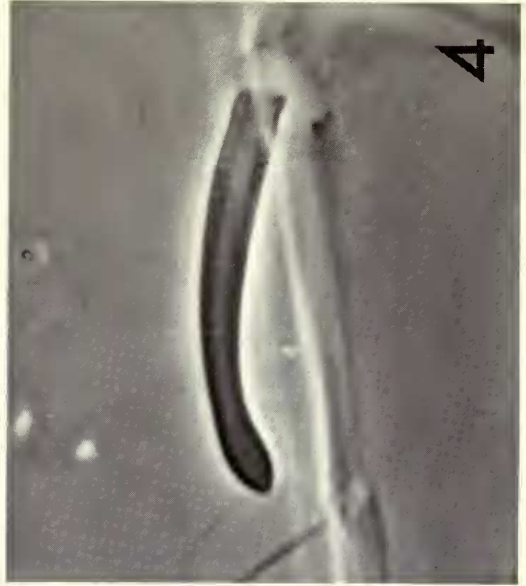


PLATE 2

Lateral view of solenidion ω_1 (ω_1) situated on tarsus II. $\times 2250$

FIG. 1. *Acarus farris* (Oudemans)

FIG. 2. *Acarus calcarabellus* sp.n.

FIG. 3. *Acarus nidicolous* sp.n.

FIG. 4. *Acarus macrocoryne* sp.n.

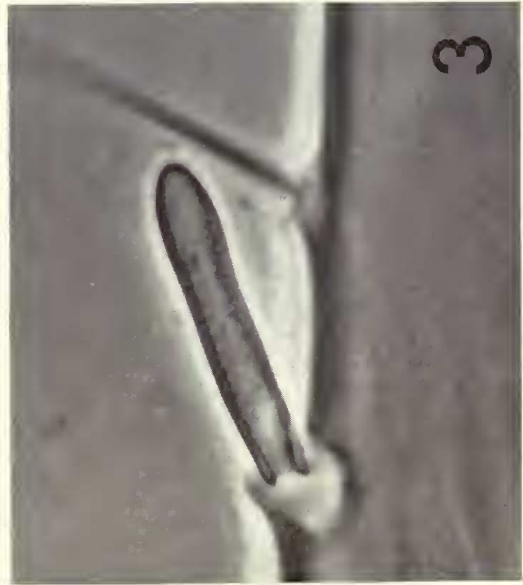


PLATE 3

Lateral view of solenidion ω_1 situated on tarsus II. $\times 2250$

FIG. 1. *Acarus* specimen *incertae sedis* ex Chinese water-chestnuts.

FIG. 2. *Acarus chaetoxysilos* *sp.n.*

FIG. 3. *Acarus* specimen *incertae sedis* ex Brazilian cocoanuts.

FIG. 4. *Acarus* specimen *incertae sedis* ex Formosan *Citrus grandis* fruit.



PLATE 4

FIG. 1. *Acarus siro* L. ♀. Apex of tarsus I showing large spine *s* curving away from pulvillus.

FIG. 2. *Acarus immobilis* Griffiths. ♀. Apex of tarsus I showing small spine *s* curving towards pulvillus.

FIG. 3. *Acarus siro* L. A scanning electron micrograph of Grandjean's organ showing its structure and position. ×3200

FIG. 4. *Acarus siro* L. A scanning electron micrograph of the supra-coxal seta. ×3200



